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MODEL 2173B
SELECTIVE VOLTMETER

2173B/2174A-B

RYCOM INSTRUMENTS

RYCOM INSTRUMENTS
Div
Railway Communications Inc
9351 E. 59th Street
Raytown Missouri
64133

M O D E L 2 1 7 3 B

SELECTIVE VOLTMETER

Serial No._____

REPLACEMENT PARTS - Specific symbol, part number of item being ordered; also serial number and model of voltmeter.

For various reasons, changes will occasionally appear in the instruction book text, parts list and drawings. Continued effort is being made to improve circuitry and use better components. During the test procedure, individual adjustments are made to obtain optimum operation. Parts procurement difficulties occasionally require substitution of different but equivalent parts.

Changes special to this unit _____

_____

CERTIFICATION

The RYCOM Instruments Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory.

WARRANTY AND ASSISTANCE

All RYCOM Instruments Products are warranted against defects in material and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed below for the specified period we will repair or replace products that prove to be defective during the warranty period. No other warranty is expressed or implied. We are not liable for consequential damages.

Exceptions in our products using dry batteries or Ni-Cad batteries the above warranty applies to the equipment only. Ni-Cad batteries are subject to original manufacturers inspection.

Where it is necessary to return the instrument to the factory, furnish information to the nature of trouble encountered. Ship prepaid to:

RYCOM INSTRUMENTS
9351 East 59th Street
Raytown, Missouri 64133

Attention: Service Department

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SELECTIVE VOLTMETER
MODEL 2173B
SER. NO.
115 VOLTS
RYCOM
INSTRUMENTS
RAILWAY COMMUNICATIONS INC.
RAYTOWN, MO.
RMS VOLTS
FREQUENCY
POWER
OFF ON METER
OFF
DB VOLTS
VOLTS DB
ATTENUATOR
250~ 2.8 KC
SELECTIVITY
BAND SELECTOR
AM LSB USB
MONITOR
MON LEV
AUDIO IN
HEADSET
CAL TRIM
CAL LEV
1A
INPUT

I. GENERAL DESCRIPTION.

1.1 GENERAL.

RYCOM Model 2173B Frequency Selective Voltmeter operates between 2 KC and 2 MC. The instrument will measure discreet frequencies in its frequency range and also demodulate AM and SSB signals in the range. The instrument will measure harmonic distortion, intermodulation products, crosstalk and transmission characteristics. This book covers the operation and maintenance of the instrument and describes the theory of operation.

1.2 EQUIPMENT DESCRIPTION.

RYCOM Model 2173B Frequency Selective Voltmeter uses a high side mixer injection to convert the desired frequency to 2.215 MC where it is filtered, amplified and detected. Before the signal is converted, it is fed through a precision attenuator which determines the sensitivity of the instrument in 10 db steps from -80 dbm to +20 dbm. Fine readings are determined by the meter from -20 to +2 db. Two passbands are selectable on the instrument: 250 cps and 2.8 KC. Also included is a standard AM detector and a linear SSB detector. The instrument includes power supplies, controls, audio amplifier, calibration circuits and a speaker.

1.2.1 PHYSICAL CHARACTERISTICS.

Size:	17" x 8-3/4" x 10" (not including carrying handle).
Weight:	28 pounds.
Construction:	Portable with carrying handle.
Cooling:	Convection.

1.2.2 OPERATING CHARACTERISTICS.

Ambient Temperature:	-10°C (14°F) to 50°C (122°F).
Ambient Humidity:	0 to 95% relative.
Altitude:	10,000 feet maximum.
Operating Duty Cycle:	Continuous.

1.2.3 ELECTRICAL CHARACTERISTICS.

Frequency Range:	2 KC to 2 MC.
Input Sensitivity:	10 uv to 10v (-100 to +22 dbm).
Input Impedance:	6K shunted by approximately 20 pf.
Selectivities:	200 to 250 cps at 3 db. 1500 cps maximum at 60 db.
	2.3 to 2.8 KC at 3 db. 13 KC maximum at 60 db.

Frequency Stability:	±100 cps after warm up in constant environment.
Accuracy:	±1 db after calibration.
Calibration Accuracy:	±0.1 db at 100 KC.
Power Input:	104 to 126V AC. 50 to 60 cps. approximately 45 watts.
Types of Detection:	AM, LSB and USB.
Harmonic Response and Distortion Products:	Less than 60 db referred to a 0 db setting on meter.

II. OPERATION.

2.1 INSPECTION.

This instrument has been thoroughly tested and inspected before shipment. It should be inspected for damage as soon as received. If no damage is apparent, proceed to 2.2 Initial Adjustments.

2.2 INITIAL ADJUSTMENTS.

After the instrument has been unpacked and inspected, plug into the proper 115V AC receptacle and allow unit to warm up. After the instrument has warmed up, perform the following tests.

a. Calibrate unit as described in 2.4.

b. With unit still in CALIBRATE, switch MONITOR to LSB and advance MONITOR LEVEL until an audible tone is heard.

c. Switch MONITOR to USB, tone should remain at approximately the same frequency and level.

d. Switch MONITOR to AM. Tone will stop and noise will be audible.

e. Adjust main tuning until reading on meter becomes -15 db. Switch SELECTIVITY from 250 cps to 2.8 KC. Reading on meter should be above 0 db.

2.3 CONTROLS.

This section lists and describes the function of all front panel controls.

POWER-METER switch S4. Applies primary power to instrument and places short across the meter in "Meter Off" position.

ATTENUATOR. Adjusts input level to front end of unit in 10 db steps from -80 dbm to +20 dbm. Calibrate position turns on calibrate oscillator and feeds calibrate signal of 100 KC into front end.

SELECTIVITY switch S2. 250 cps (for measurements) or 2.8 KC (for monitoring) IF bandwidths

Tuning capacitor C54. Selects frequency to be measured in conjunction with band selector by varying main tuning capacitor.

BAND SELECTOR switch S3. Selects frequency band for instrument to operate. Five positions.

MONITOR switch S5. Turns on product detector, feeds proper audio into audio amplifier and chooses proper SSB crystal.

MON LEV (monitor level) control R103. Adjusts amount of drive to audio amplifier.

CAL TRIM (calibrate trimmer) capacitor C53. Used to set frequency on calibration points or as a fine tuning adjustment.

CAL LEV (calibrate level) control R102. Used to set IF gain in level calibrate procedure.

2.4 CALIBRATE PROCEDURE.

The following procedure will calibrate the instrument for level and frequency.

The procedure is performed at 100 KC, the fundamental frequency of the crystal calibrate circuit. Other frequency check points every 100 KC to approximately 1 MC are available by using the harmonics of the crystal calibrator.

a. Preliminary setting:

ATTENUATOR - CAL position.
POWER-METER - ON.
SELECTIVITY - 250 ~ .
TUNING - exactly 100 KC.
BAND SELECTOR - A.

b. Procedure:

Adjust CAL TRIM for maximum meter indication.
Adjust CAL LEV for exactly 0 db on top meter scale.
The unit is now calibrated in volts at the input or in dbm into 600 ohms.

2.5 MEASUREMENTS.

All measurements are made with the selectivity in the 250 cps position. To search for a signal it is at times easier to use the 2.8 KC selectivity and then switch to 250 cps for measurements.

2.5.1 SELECTIVE VOLTMETER MEASUREMENTS.

a. Preliminary setting:

POWER-METER - ON.
ATTENUATOR - lowest level to be measured.
SELECTIVITY - 250 ~ .
Calibrate instrument as described in Section 2.4.

Tuning capacitor C54. Selects frequency to be measured in conjunction with band selector by varying main tuning capacitor.

BAND SELECTOR switch S3. Selects frequency band for instrument to operate. Five positions.

MONITOR switch S5. Turns on product detector, feeds proper audio into audio amplifier and chooses proper SSB crystal.

MON LEV (monitor level) control R103. Adjusts amount of drive to audio amplifier.

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2.4 CALIBRATE PROCEDURE.

The following procedure will calibrate the instrument for level and frequency.

The procedure is performed at 100 KC, the fundamental frequency of the crystal calibrate circuit. Other frequency check points every 100 KC to approximately 1 MC are available by using the harmonics of the crystal calibrator.

a. Preliminary setting:

ATTENUATOR - CAL position.
POWER-METER - ON.
SELECTIVITY - 250 ~ .
TUNING - exactly 100 KC.
BAND SELECTOR - A.

b. Procedure:

Adjust CAL TRIM for maximum meter indication.
Adjust CAL LEV for exactly 0 db on top meter scale.
The unit is now calibrated in volts at the input or in dbm into 600 ohms.

2.5 MEASUREMENTS.

All measurements are made with the selectivity in the 250 cps position. To search for a signal it is at times easier to use the 2.8 KC selectivity and then switch to 250 cps for measurements.

2.5.1 SELECTIVE VOLTMETER MEASUREMENTS.

a. Preliminary setting:

POWER-METER - ON.
ATTENUATOR - lowest level to be measured.
SELECTIVITY - 250 ~ .
Calibrate instrument as described in Section 2.4.

b. Procedure:

Tune frequency range of interest by using TUNING and BAND SELECTOR. Tune from low to high frequency. Whenever a signal is found the meter will deflect. Change ATTENUATOR so that reading is on scale. Note frequency and level. CAUTION: Instrument will overload and generate harmonics and intermodulation products of signals applied to the input approximately 70 db down. These should not be mistaken for signals. A test to determine if the indication is a signal or internally generated is to see if it varies linearly with attenuator setting (internally generated signals will increase 20 db for a 10 db increase in ATTENUATOR setting).

2.5.2 HARMONIC DISTORTION MEASUREMENTS.

Harmonics distortion is measured by comparing the ratio of the harmonics to the fundamental frequency.

a. Preliminary setting:

Calibrate instrument as described in 2.4.

b. Procedure:

Using the procedure described in 2.5.1 measure f_o and the related harmonics. If total harmonic distortion is required, it can be calculated by the following formula.

$$\text{Distortion in } \% = \sqrt{\frac{V_{f2}^2 + V_{f3}^2 + V_{f4}^2 \ldots + V_{fn}^2}{V_{fo}^2 + V_{f2}^2 + V_{f3}^2 + V_{f4}^2 \ldots + V_{fn}^2}} \times 100$$

Calculation of distortion by using only the 2nd and 3rd harmonics gives a very small error. Also, if the distortion is under 5% the formula can be approximated.

$$\text{Distortion in } \% \cong \sqrt{\frac{V_{f2}^2 + V_{f3}^2}{V_{fo}^2}} \times 100$$

Note: For measuring distortion products lower than -60 db, a lowpass filter or notch filter should be used to eliminate the fundamental frequency.

2.5.3 INTERMODULATION DISTORTION MEASUREMENTS.

Intermodulation distortion measurements are made by comparing the levels of distortion products to the levels of two equal test tones.

a. Preliminary setting:

Calibrate instrument as described in 2.4.

b. Procedure:

Using the procedure described in 2.5.1 measure the fundamental frequencies and the distortion products.

F1 and f2 (fundamental frequencies)

Examples of intermodulation distortion are:

f2 - f1
f1 + f2 2nd order products

2f1 - f2
2f2 - f1 3rd order products

2f2 - 2f1
2f1 + 2f2 4th order products

3f2 - 2f1
3f1 - 2f2 5th order products

In normal measurements the 3rd and 5th order distortion products are the only ones measured.

2.5.4 CROSSTALK MEASUREMENTS.

Crosstalk is the undesired coupling of a signal in one pair of wires or circuit to another pair of wires or circuit.

a. Preliminary setting:

Calibrate instrument as described in 2.4.
Drive one pair of wires or circuit with a signal between 0 dbm and +10 dbm.

b. Procedure:

Measure the signal voltage into driven pair. Measure level on pair not being driven. The ratio of the two signals is the crosstalk and can be measured to -100 db.

2.6 DEMODULATION.

The RYCOM Model 2173B is equipped with AM and SSB detector and a demodulation bandwidth of approximately 2.8 KC. Three KC AM and SSB signals can be demodulated and listened to on the speaker included or on external earphones.

2.6.1 AM DEMODULATION.

a. Preliminary setting:

POWER-METER - ON.
SELECTIVITY - 2.8 KC.
MONITOR - AM.
MON LEV - audible noise is heard.
CAL LEV - fully CCW.

b. Procedure:

Find signal by appropriate setting of BAND SELECTOR, tuning and ATTENUATOR.
Adjust ATTENUATOR for a meter reading of -5 db to off scale (if reading is less than -5 db use next lower attenuator setting).
Adjust TUNING for best audio.

2.6.2 SSB DEMODULATION.

a. Preliminary setting:

POWER-METER - ON.
SELECTIVITY - 2.8 KC.
MON LEV - audible noise is heard.
CAL LEV - fully CCW.

b. Procedure:

Switch MONITOR to desired demodulation (LSB or USB). Find signal by appropriate setting of BAND SELECTOR, tuning and ATTENUATOR. Adjust ATTENUATOR for a meter reading of -8 db to +2 db.
Adjust tuning for best audio.

III. PRINCIPLES OF OPERATION.

3.1 GENERAL.

This section consists of a circuit analysis of the selective voltmeter paralleling the block diagram and the schematic. The major portions of the selective voltmeter are:

a. Input Circuit - processes signal to drive mixer.

b. Oscillator Mixer - determines operating frequency.

c. IF Amplifier - determines selectivity and has gain to drive the detectors.

d. Detectors - rectifies signal for meter and processes signal for audible observation.

e. Audio amp - drives speaker or headset.

f. Cal oscillator - provides frequency and level reference.

g. Power supply - provides voltages to operate unit.

3.2 CIRCUIT DESCRIPTION.

3.2.1 INPUT CIRCUIT.

The input circuit consists of four parts--type BNC in receptacle, 100 db attenuator, 2.215 MC notch filter and a video amplifier.

The input signal is fed into a type BNC receptacle and coupled into the attenuator by C1. The attenuator is a voltage divider. The signal is picked off by the arm of the attenuator and fed through the 2.215 MC notch filter to the grid of V1, the video amplifier. The 2.215 MC notch filter is a parallel tuned T filter which provides approximately 30 db of attenuation to 2.215 MC and 6 db of attenuation to frequencies above 2.215 MC. The video amplifier (V1) is a cathode follower which isolates the local oscillator from the input jack and impedance matches the input signal to the mixer (V2). The signal is coupled from the cathode of V1 through R2 and C3 into the mixer.

3.2.2 MIXER AND LOCAL OSCILLATOR.

This section consists of the mixer (CR3), phase splitter (V7) and local oscillator (V8).

The input signal from V1 is heterodyned (mixed) with the local oscillator signal in mixer diodes CR3. The mixer diodes operate as a balanced shunt mixer and short the signal to ground during half the local oscillator cycle. The output of the mixer is direct coupled to the grid of mixer amplifier V2.

The phase splitter V7 drives the mixer diodes into conduction during half a local oscillator cycle. Conduction occurs when the signal on the plate of V7 is negative and the signal on the cathode of V7 is positive. The local oscillator signal level at the junction of the mixer diodes is extremely small because of the matching of the diodes. The drive to the phase splitter is obtained from the local oscillator through C35.

The local oscillator V8 is of the Hartley type in a ground plate configuration. The frequency of the oscillator within each band is varied by C54. The band switch S3 determines the operating band. C53 is used to frequency calibrate the unit and as a fine adjustment for frequency setting. Capacitors C50 and C51 are temperature compensating and determine the frequency stability of the oscillator and voltmeter.

For the selective voltmeter to tune a frequency the following equation applies. Local Oscillator = Desired Frequency + 2.215 MC.

3.2.3 IF AMPLIFIER.

This section consists of the mixer amplifier, crystal filters and the three IF stages.

The grid of mixer amplifier V2 is direct coupled from the mixer and supplies approximately 20 db of gain to the 2.215 MC converted signal. The output of the mixer amplifier V2 is coupled by C4 into the A section of switch S2. S2 selects the input and output of either crystal filter FL2 or FL3 and grounds the unused filter. The B section of S2 connects the output of either filter to the grid of V3 the first IF amplifier. The major portion of the selectivity is determined by the crystal filters. The 250 cps filter FL2 is used for measuring and the 2.8 KC filter FL3 is used for monitoring. Both the inputs and outputs of the crystal filters are tuned to give a "flat" passband response.

The major portion of gain in the selective voltmeter is obtained in the three IF stages V3, V4 and V5. The gain of these stages is approximately 100 db. The IF stages are of conventional design and transformer coupled. The first IF stage V3 and the third IF stage V5 are fixed in gain and the tubes are sharp cutoff. The second IF stage V4 is variable in gain and is a remote cutoff tube. R101 (CAL LEV) adjusts the gain of V4 by changing the plate current. The plate voltage of the third IF V5 is obtained through a divider R18 and R19 to limit its peak output and protect the meter circuit from overload. The secondary of IF transformer T3 is short circuited to prevent possible interaction with the primary. The output of the third IF stage drives the detectors.

3.2.4 DETECTORS.

This section describes the AM-Meter detector and the SSB detector. (AM = amplitude modulation, SSB = single sideband).

A single detector diode CR2 drives both the meter and AM audio circuits. The IF signal is coupled through C27 into the AM-Meter detector CR2. The audio is taken from the cathode side of CR2 and feed through a lowpass filter R30 and C30 to the monitor switch S5. R51 is a dummy load for the detector when AM is not being used. The Meter drive is fed through a lowpass filter R31 and C31 to the meter. R32 improves the damping characteristics of the meter.

The SSB detector V9 is a self-excited electrostatically deflected sheet beam demodulator. This type of demodulator has extremely good linearity and AM rejection. The self-excited crystal oscillator operates as a pierce oscillator using the screen of V9 as a plate. The crystal frequencies lie immediately above and below the 2.8 KC crystal filter so that either LSB or USB can be demodulated. The crystal below the 2.8 KC crystal filter is used to demodulate LSB. IF signal from the plate circuit of the third IF is fed through divider R28 and R29 to one of the deflection plates (pin 9) of V9. The demodulated SSB signal is taken from one of the plates (pin 7) of V9. The demodulated SSB signal is then fed through lowpass filter R50 and C61 to the monitor switch. The monitor switch also determines which crystal the SSB detector will use.

3.2.5 AUDIO AMPLIFIER.

The audio amplifier V10 is a single class A transformer output stage which will drive either the speaker or headphones. The plate supply to this stage is not regulated. The drive for the audio amplifier is selected by the monitor switch. The drive level is determined by R103 (monitor level). The output can be monitored by the speaker or with a pair of external head phones.

3.2.6 CALIBRATE OSCILLATOR.

This section is composed of a 100 KC crystal oscillator and a clipper. The oscillator V6 is a pierce type circuit with the output coupled through R23 and C23 into the clipper diode CR1. The clipper is thermally stable but must be set levelwise for each diode. R102 sets the exact level. The output of the limiter is fed into the attenuator in the CAL position and used to calibrate the selective voltmeter for both level and frequency. Level can be set only at 100 KC but frequency can be set on 100 KC increments to approximately 1 MC by using the 100 KC harmonics.

3.2.7 POWER SUPPLY

The power supply consists of a transformer, rectifier, filter, 150V regulator and 75V regulator.

The transformer (T5) output is rectified by selenium bridge rectifier CR4. Filtering is done by C64b and C64c and L7. The output of the filter is approximately +225V. The +225V is fed through dropping resistor R53 to V11, the +150V regulator. The regulated +150V is fed through dropping resistor R54 to CR5 the +75V regulator. Capacitor C65 is a noise suppressor.

Voltage	Operates
+225V Non-regulated	Audio Amp and 150V Regulator
+150V Regulated	CAL OSC, Video Amp, Mixer Amp, IF Amplifiers, SSB Detector and +75V Regulator
+75V Regulated	Local Osc and Phase Splitter
6.3V AC	All filaments and dial lights

IV. MAINTENANCE.

4.1 REQUIRED TEST EQUIPMENT.

4.1.1 Sweep generator and display with the following characteristics.

Frequency - any between 40 KC and 1.9 MC.
Sweep Range - variable between 1 KC and 40 KC.
Sweep Rate - approximately 2 seconds.
Signal Output - any between .1 volts and 10 volts.
Display - visual (oscilloscope).

4.1.2 AC vacuum tube voltmeter with a minimum sensitivity of 5 volts full scale and frequency response flat to 2 MC.

4.1.3 Signal Generator or Signal Generators.

Frequency Range - 1 KC to 2.3 MC.
Frequency Accuracy - 1 part in 10^5.
Output Level - -80 dbm to +20 dbm.
Output Level Accuracy - $\pm$.2 db.

Alternate: Use separate AC vacuum tube voltmeter to obtain level accuracy.
Use separate counter to obtain frequency accuracy.

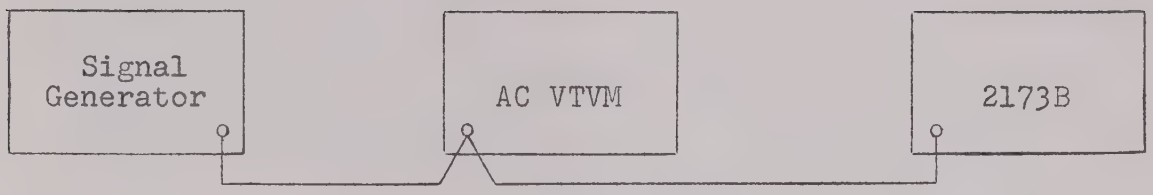
4.2 ALIGNMENT.

The selective voltmeter is completely aligned at the factory and should not be realigned as routine maintenance.

CAUTION: Alignment of the crystal filters and the IF transformer should not be attempted without using a sweep "set up."

4.2.1 Calibrate Oscillator Adjustment.

a. Test Setup:



b. Preliminary settings:

1) Signal Generator.
100 KC at 0 dbm (.776 volts).

2) 2173B Selective Voltmeter.
Selectivity - 250 cps.
Band Selector - A.
Attenuator - 0 db (1 volt).
Power-Meter - ON.
Main Tuning - Exactly 100 KC.

c. Procedure:

1) Tune signal generator for maximum 2173B meter reading.

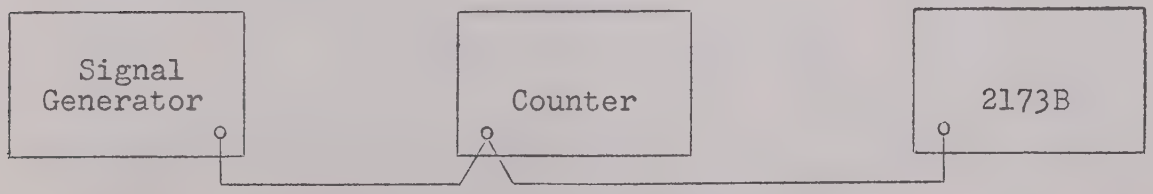
2) Adjust CAL LEV for exact 0 db meter indication.

3) Set ATTENUATOR in CAL position and adjust CAL TRIM for maximum meter reading.

4) Adjust R102 (CAL ADJ) for exact 0 db meter indication.

4.2.2 Local Oscillator Adjustment.

a. Test Setup:



CAUTION: Entire local oscillator adjustment procedure must be performed in sequence.

b. Preliminary settings:

1) Signal Generator.
As listed in c below.

2) 2173B Selective Voltmeter.
Selectivity - 250 cps.
Power-Meter - ON
Cal Trim - capacitor plates half meshed.
Monitor - LSB
Mon Lev - Audible Noise.
Attenuator - compatible with signal generator output.

c. Procedure:

1) Set band selector on band F.
Set signal generator to 1.9 MC.
Set 2173B main tuning to 1.9 MC.
Adjust C49(F) for maximum meter indication.

2) Set signal generator to 1.3 MC.
Set 2173B main tuning to 1.3 MC.
Adjust L6 for maximum meter indication.

3) Set signal generator to 1.9 MC.
Set 2173B main tuning to 1.9 MC.
Adjust C49 for maximum meter indication.

4) Repeat steps 2 and 3 until further adjustment of C49 and L6 does not increase meter reading.

5) Set band selector on band E.
Set signal generator to 1.05 MC.
Set 2173B main tuning to 1.05 MC.
Adjust C47(E) for maximum meter indication.

6) Set Band Selector on band D.
Set signal generator to 700 KC.
Set 2173B main tuning to 700 KC.
Adjust C45(D) for maximum meter indication.

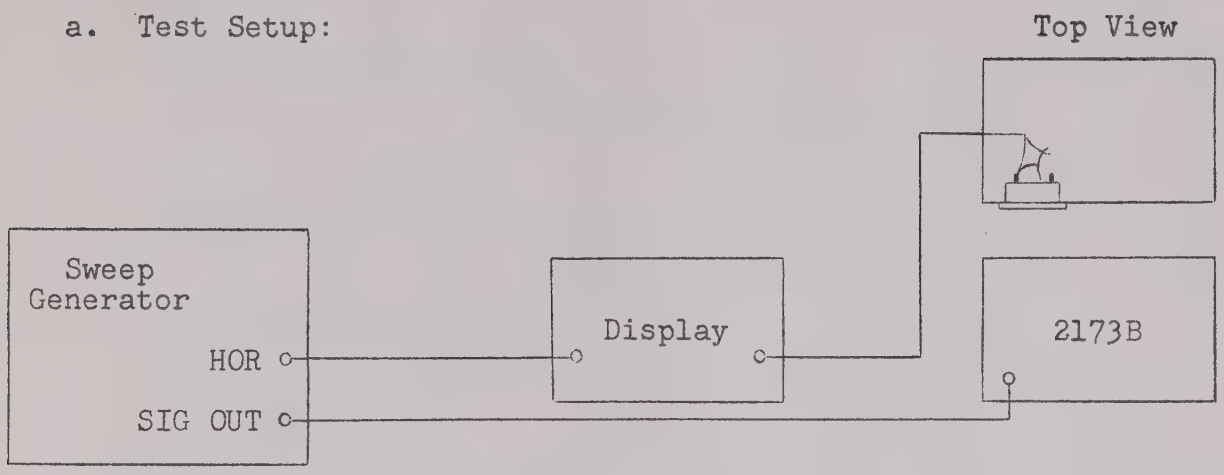
7) Set Band Selector to band C.
Set signal generator to 450 KC.
Set 2173B main tuning to 450 KC.
Adjust C43(C) for maximum meter indication.

8) Set Band Selector to band B.
Set signal generator to 250 KC.
Set 2173B main tuning to 250 KC.
Adjust C41(B) for maximum meter indication.

9) Set Band Selector to band A.
Set signal generator to 100 KC.
Set 2173B main tuning to 100 KC.
Adjust C39(A) for maximum meter indication.

4.2.3 IF Amplifier Adjustment.

a. Test Setup:



b. Preliminary settings:

1) Sweep Generator.
Sweep rate 2 seconds.
Sweep width 40 KC.
Frequency output between 40 KC and 1.9 MC.

2) 2173B Selective Voltmeter.
Remove the inner conductor of the shielded wire from the meter and connect to the vertical of the display.
Place a 27 to 47Ω resistor from the grid (pin 1) of V3 to chassis ground.
Connect a wire from the arm of S2a (SELECTIVITY) to the grid (pin 1) of V3.
SELECTIVITY 250 cps.
ATTENUATOR compatible with the output of the sweep generator.
POWER-METER ON.
CAL LEV fully CCW.

c. Procedure:

1) Adjust the BAND SELECTOR and main tuning until the response appears on the display unit.

2) Adjust T1 (top and bottom), T2 (top and bottom) and T3 (bottom) until the response is flat or slightly dipped around the marker. The marker is caused by the response of the 250 cps crystal filter. CAUTION: The ATTENUATOR must be adjusted so the IF amplifier is not overloaded.

4.2.4 Crystal Filter Adjustment. (Tune IF amplifier before tuning the crystal filters).

a. Test Setup (same as 4.2.3).

b. Preliminary Settings.

1) Sweep Generator.
Sweep rate 2 seconds.
Sweep width - 10 KC for 2.8 KC filter.
1 KC for 250 cps filter.
Frequency output between 40 KC and 1.9 MC.

2) 2173B Selective Voltmeter.
SELECTIVITY - 2.8 KC for 2.8 KC filter.
250 ~ for 250 cps filter.
POWER-METER - ON.
CAL LEVEL - 50% of rotation.
ATTENUATOR - compatible with sweep generator output.

c. Procedure.

1) Adjust the BAND SELECTOR and main tuning until a response appears on the display unit.

2) 2.8 KC filter. Adjust C7 and C9 for a "flat" response.

3) 250 cps filter. Adjust C6 and C8 for a "flat" to "bullet nosed" response.

4.3 TROUBLE SHOOTING.

4.3.1 Test Procedure.

This procedure is not to be used to determine if the selective voltmeter is functioning properly. The procedure is a fault localizing procedure and should be done in sequence.

Circuits under Test	Procedure
a) IF Amplifier and meter circuit	CAL LEV-CCW Place 27 to 47Ω resistor from grid of V3 (pin 1) to chassis ground. Drive grid of V3 with a 2.215 MC sig. Maximum level for 0 db meter reading 170 uv.
b) SSB Demodulator and Audio Amplifier	CAL LEV - CCW MONITOR - LSB MONITOR LEV - 50% rotation Perform check a) on IF Amplifier and meter circuit. Drive V3 at the level to get 0 db reading on meter. Audio tone should be on speaker.

(Chart continued on next page)

c) Input Circuit and Filters	CAL LEV - CCW Drive the input connector with a 2.215 MC signal and obtain a 0 db reading on meter. The input level should be approximately 30 db up from the ATTENUATOR setting.
d) Local Oscillator or Mixer	If test a,b and c indicate no trouble, the trouble is in the local oscillator, phase splitter or mixer.

4.3.2 Possible Troubles.

Trouble	Cause
a) High noise level at low frequencies	C65 open.
b) High local oscillator leakage at low frequencies	Component trouble with R33, R34, R35, R36, C32, C33, V7 or FL2.
c) Excessive 60, 120 or 180 cps output on SSB monitoring	1. Selective voltmeter is in a high magnetic field and V9, 7360, is being magnetically modulated. 2. Power supply filter trouble.
d) Meter reading does not track	Component trouble with CR2, 1N277.
e) No dial light	Remove frequency tuning knob and cover. Replace defective lamp. NOTE: Spring is loose on shaft, don't lose. See f for knob replacement.
f) Dual speed frequency drive does not function	Adjust spring tension on knob. Depress knob and tighten set screw. Check rotation to see that spring has sufficient tension to raise knob, shaft & gear enough to engage speed reduction gear. Check rotation with knob depressed to see if spring will compress enough to engage direct drive.
g) To remove unit from case remove only the screws around the edge of the front panel.	

Voltage Chart: Preliminary Settings
METER-POWER - ON
CAL LEV - CCW
ATTENUATOR - CAL
MONITOR - LSB
BAND SELECTOR - B

Tube No	Pin No										
	1	2	3	4	5	6	7	8	9	10	12
V1 6CW4	-	67VDC	-	0	-	-	-	1.3VDC	0	0	6.3VAC
V2 6CW4	-	110VDC	-	0	-	-	-	.9VDC	-	0	6.3VAC
V3 6BH6	0	1.9VDC	6.3VAC	0	145VDC	138VDC	0	-	-	-	-
V4 6BJ6	0	11VDC	6.3VAC	0	150VDC	145VDC	0	-	-	-	-
V5 6BH6	0	1.9VDC	6.3VAC	0	100VDC	142VDC	0	-	-	-	-
V6 6CW4	-	90VDC	-	-9.5VDC	-	-	-	.4VDC	-	0	6.3VAC
V7 6CW4	-	70VDC	-	-.1VDC	-	-	-	2.5VDC	-	0	6.3VAC
V8 6CW4	-	73VDC	-	-4.5VDC	-	-	-	.4VDC	-	-	6.3VAC
V9 7360	4VDC	138VDC	-1VDC	0	6.3VAC	65VDC	65VDC	18VDC	18VDC	-	-
V10 6AQ5	-	17VDC	6.3VAC	0	225VDC	230VDC	0	-	-	-	-
V11 0A2	150VDC	0	-	-	150VDC	-	-	-	-	-	-

Symbol	Part No	Mfg	Description
AT	2173B-1	L	Attenuator, 100 db 10 steps plus CAL pos
C1			Cap., .22 uf ±20% 400 WVDC metalized mylar
C2,3			Cap., .47 uf ±10% 200 WVDC metalized mylar
C4,26-28,30 38,60,61			Cap., .001 uf ±20% 500 WVDC disc ceramic
C5			Cap., 110 pf ±5% 500 WVDC silver mica AR
C6,7,8,9	Style 557	H	Cap., 5-25 pf NPO 350 WVDC variable ceramic
C10,14,15, 18,29,31-33 36,55,57,62			Cap., .01 uf GMV 200 WVDC disc ceramic
C11,13,16 17,19-23,56, 63,67			Cap., .01 uf GMV 500 WVDC disc ceramic
C12,34,66			Cap., .1 uf ±20% 200 WVDC tubular mylar
C24			Cap., 500 pf ±5% 500 WVDC silver mica
C25			Cap., 250 pf ±5% 500 WVDC silver mica
C35,37			Cap., 100 pf ±5% 500 WVDC silver mica
C39,41,43 45,47,49	Style 503	H	Cap., 4.5-25pf NPO 350 WVDC variable ceramic
C40,42,44 46			Cap., 100 pf ±5% 500 WVDC disc ceramic NPO
C48			Cap., 110 pf ±5% 500 WVDC disc ceramic NPO
C50			Cap., 22 pf ±5% 500 WVDC disc ceramic N330
C51			Cap., 155 pf ±5% 200 WVDC disc ceramic N080
C52			Cap., 47 pf ±5% 500 WVDC disc ceramic NPO
C53	Spec 4197	B	Cap., 4-10 pf var. air 4 turn
C54	167-153-10	G	Cap., 12-150pf variable air
C58			Cap., 200 pf ±5% 500 WVDC silver mica
C59			Cap., 22 pf ±5% 500 WVDC silver mica
C64			Cap., 40-40-20 uf 450-450-25 WVDC electrolytic
C65			Cap., 5 uf ±20% 100 WVDC metalized mylar
CR1	1N755		Diode, 7.5V, .4 watt, zener
CR2	1N277		Diode, Germanium, signal
CR3	*1N4306		Diode, silicon, signal matched pair
CR4	*61-4037	I	Rectifier, selenium, 100 ma, 240V dc max
CR5	1N1792		Diode, 75V, 1 watt zener
DS1,2	47		Lamp, incandescent, 6.3V, 150 ma
F1	AGC1		Fuse, 1 amp
FL1	2173B-4	L	Filter, 2.215 MC notch
FL2		E	Filter, 2.215 MC c.f., 250 ~ bw
FL3		E	Filter, 2.215 MC c.f., 2.8 KC bw
J1	UG1094/U		Receptacle, coax
J2,3	12A	N	Jack
J4	903PMTH	A	Connector, receptacle electrical
L1	3047-12	Q	Coil, radio freq 47 uh AR
L2,4	1500-12	Q	Coil, radio freq 500 uh
L3,8	3063-12	Q	Coil, radio freq 63 uh
L5	2366-3A	L	Coil, radio freq, tapped
L6	2173B-5	L	Coil, radio freq, slug tuned

Symbol	Part No	Mfg	Description
L7	TTI-3133	O	Reactor, 7 hy
LS1	V35A47	P	Loudspeaker 3.2Ω, PM, 3½"
M	46-4782-0000	C	Meter, 0-200 ua, 2%
R1			Res., 2.2K ½W ±10% carbon
R2			Res., 2.7K ½W ±10% carbon
R3,37,47			Res., 120K ½W ±10% carbon
R4,30,43 48,50			Res., 10K ½W ±10% carbon
R5,10,15 17			Res., 6.8K ½W ±10% carbon
R6			Res., 160Ω ½W ±5% carbon
R7,11,12			Res., 1K ½W ±10% carbon
R8,18			Res., 10K ½W ±5% carbon
R9,14,16			Res., 430Ω ½W ±5% carbon
R13,55			Res., 270K ½W ±10% carbon AR
R19			Res., 51K ½W ±5% carbon
R20			Res., 1.3K ¼W ±1% deposited carbon
R21			Res., 26.1K ½W ±1% deposited carbon
R22			Res., 130Ω ¼W ±1% deposited carbon
R23			Res., 18K ½W ±10% carbon
R24			Res., 22K ½W ±10% carbon
R25			Res., 150Ω ½W ±10% carbon
R26,39			Res., 270Ω ½W ±10% carbon
R27			Res., 100K ½W ±10% carbon
R28,31,44,45			Res., 47K ½W ±10% carbon
R29			Res., 8.2 ½W ±10% carbon
R32			Res., 4.7K ½W ±10% carbon
R33,34			Res., 487Ω ½W ±1% deposited carbon
R35,36			Res., 1.6K ½W ±5% carbon
R38			Res., 110Ω ½W ±5% carbon
R40			Res., 27K ½W ±10% carbon
R41			Res., 82K ½W ±10% carbon
R42			Res., 12K ½W ±10% carbon
R46			Res., 820Ω ½W ±10% carbon
R51			Res., 240K ½W ±5% carbon
R52			Res., 820Ω 2W ±10% carbon
R53			Res., 1.5K 10W ±10% wire wound
R54			Res., 8.2K 1W ±10% carbon
R101	JF7539	F	Res., 5K ½W ±30% variable, linear, 3/8"shaft
R102	NB3153	F	Res., 1.2K ½W ±30% variable, linear, 1/8"shaft
R103	NB3152	F	Res., 250K ½W ±30% variable, audio, 3/8" shaft
S1	73B-S1	L	Switch, rotary, 3 deck 3 pole, 12 pos
S2	73B-S2	L	Switch, rotary, 2 deck 2 pole, 2 pos
S3	73B-S3	L	Switch, rotary, 1 deck 1 pole, 6 pos
S4	73B-S4	L	Switch, rotary, 1 deck 1 pole, 2 pos with SPST, 3 amp, 125V power switch
T1,2,3	R10,000	M	Transformer, 2.215 MC IF
T4	TTI-3134	O	Transformer, output, 600Ω sec, tapped at 3.2Ω
T5	TTI-3135	O	Transformer, pwr 115V pri, 230 & 6.3V sec
S5	74A-S5	L	Switch, rotary, 1 deck 3 pole, 3 pos

Symbol	Part No	Mfg	Description
V1,2,6 7,8	6CW4	K	Electron Tube, triode
V3,5	6BH6		Electron tube, pentode
V4	6BJ6		Electron tube, pentode
V9	7360		Electron tube, sheet beam
V10	6AQ5		Electron tube, pentode
V11	OA2		Electron tube, 150V regulator
WA		A	Cord, 3 wire power
Y1	116K	J	Crystal, 100 KC
Y2	157K	J	Crystal, 2213.50 KC
Y3	158K	J	Crystal, 2216.50 KC

List of Manufacturers.

A Alden Products Company
B All Star Products Inc
C Assembly Products Inc
D Belden Mfg Company
E Blackhawk Engineering Company or Midland Mfg Co
F CTS Corporation
G E.F. Johnson Company
H Erie Technological Products Inc
I International Rectifier Corp
J James Knights Company or Electronic Research
K Radio Corporation of America
L RAILWAY COMMUNICATIONS INC
M Stanwyck Winding Company
N Switchcraft Inc
O Transformer Technicians Inc
P Utah Radio Products
Q Wilco Corporation
R Semicon Inc

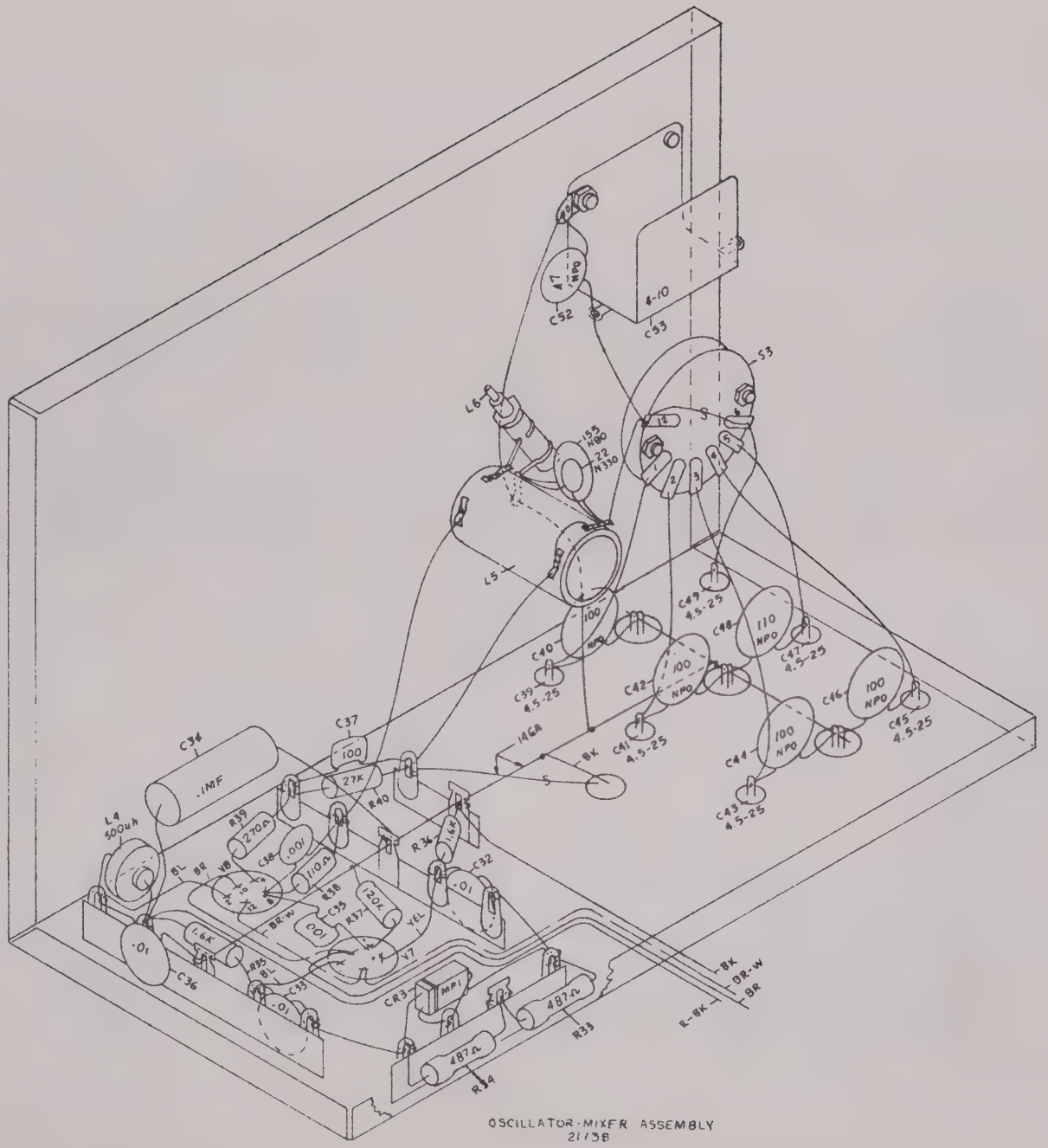
Abbreviations.

GMV Guaranteed min. value.
c.f. Center frequency.
bw Bandwidth.
PM Permanent magnet.
AR Used only as required.

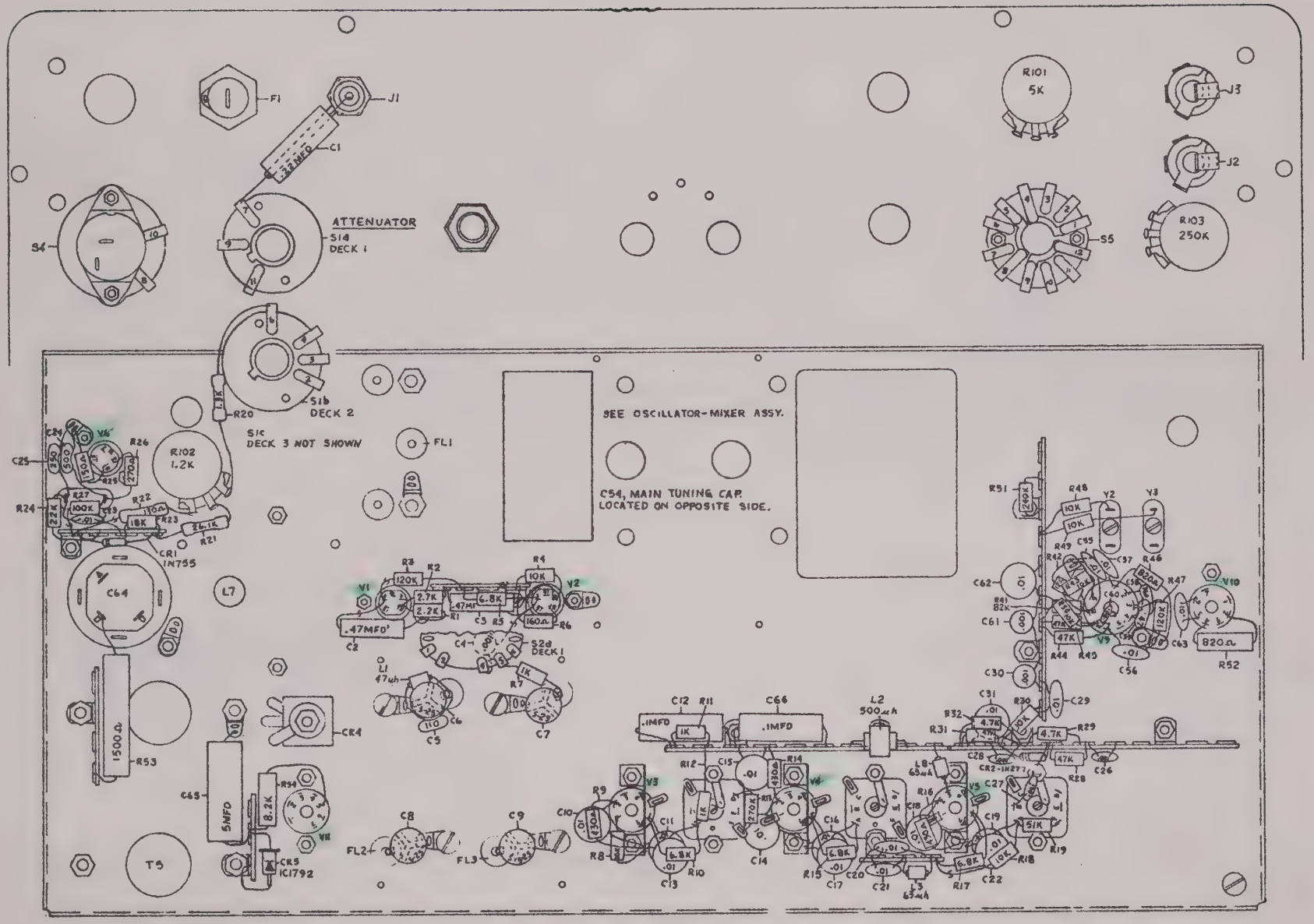
PARTS LIST ADDENDUM

Serial No	Symbol	Part No	Mfg	Description
213-314	CR3	MP-1 or 1N4306	S	Diode; silicon signal, matched pair in rectangular case
315-414	CR3a, CR3b	1N3605		Diode; silicon signal, matched pair uncased
415 up	CR3a, CR3b	RY4306	L	Diode; silicon signal, matched pair in clear plastic case (interchangeable with 1N4306)
213-314	CR4			Rectifier; bridge, selenium, 100 ma, 240V DC max
315 up	CR4,	3055-1	L	Rectifier; bridge, silicon, 1.5 amp, 560V rms
		SM180	R	Diode; silicon, 850 ma, 800 PVI (replacement diode for 3055-1 assy)

S General Electric



OSCILLATOR-MIXER ASSEMBLY
21738



COMPONENT ASSEMBLY
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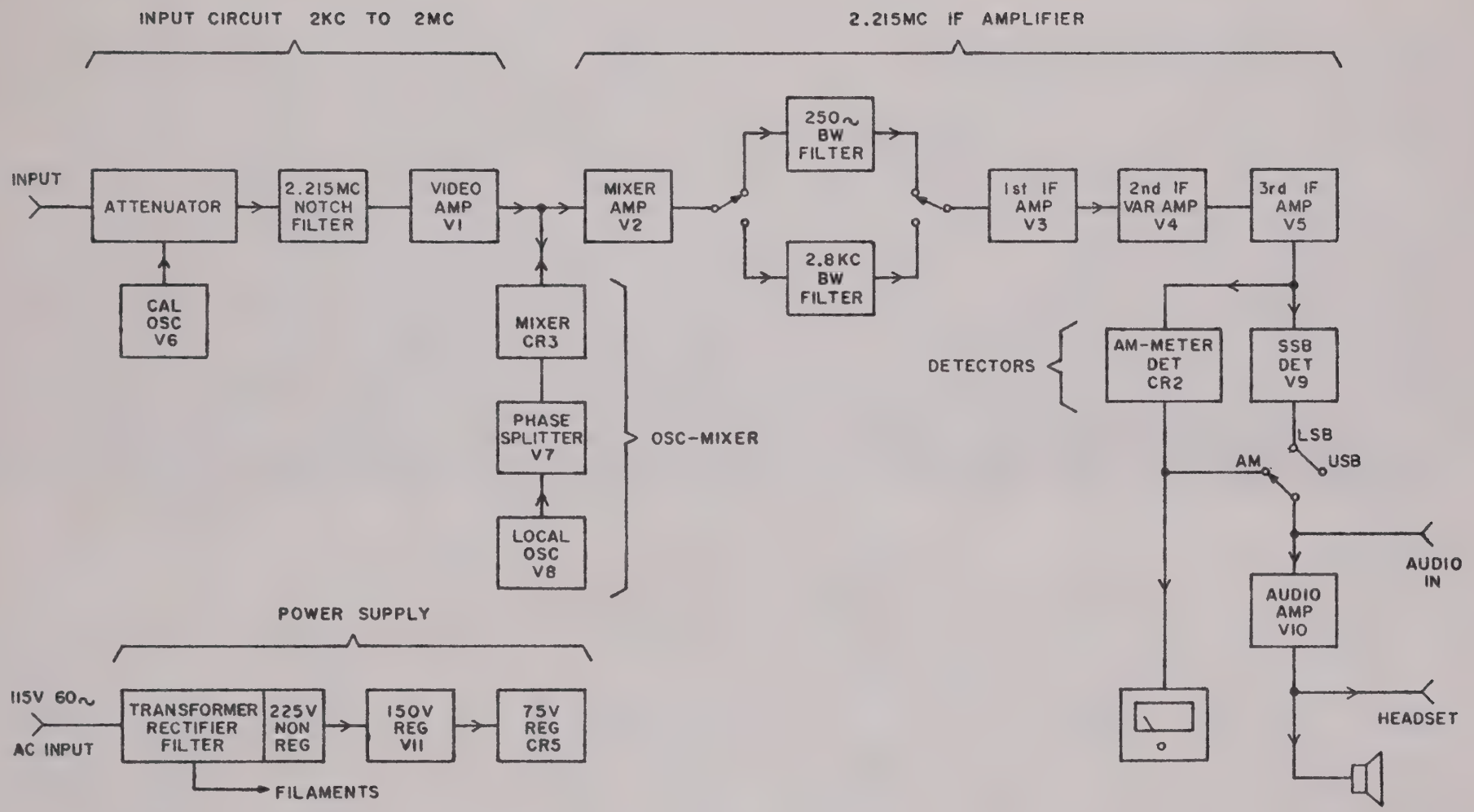


BLOCK DIAGRAM
21738

INPUT CIRCUIT

2.215MC IF AMPLIFIER

J1 INPUT

C1 .22UF

FL1 IN OUT GND

C2 .47UF

R3 120K

V1 6CW4

R1 2.2K

R2 2.7K

C3 .47UF

V2 6CW4

R4 10K

R5 6.8K

R6 160

USED AS REQUIRED

C5 110

L1 47UH

C6 5-25

FL2 IN OUT GND

C8 5-25

C4 .001UF

250~

2.8KC

S2a

S2b

R7 1K

C7 5-25

FL3 IN OUT GND

C9 5-25

SELECTIVITY

SELECTIVITY

V3 6BH6

T1

R8 10K

R10 6.8K

R13 270K

C10 .01UF

R9 430

C11 .01UF

V4 6BJ6

T2

R55 270K

R15 6.8K

C16 .01UF

C14 .01UF

R14 430

C15 .01UF

R101 5K

CAL LEV

V5 6BH6

T3

R17 6.8K

R18 10K

C18 .01UF

R16 430

C19 .01UF

R19 51K

C22 .01UF

R12 1K

C13 .01UF

R11 1K

C12 .1UF

L2 500UH

L3 63UH

+150V

C17 .01UF

C20 .01UF

C21 .01UF

AT

CAL

-80

+20

ATTENUATOR

CAL OSC

R20 1.3K

R102 1.2K CAL ADJ

R21 26.1K

R22 130

CR1 IN755

R23 18K

C23 .01UF

CAL

+150

R24 22K

V6 6CW4

Y1

C25 250

R26 270

C24 500

R25 150

R27 100K

SSB DETECTOR

AM-METER DETECTOR

R28 47K

C27 .001UF

C26 .001UF

R29 8.2K

CR2 IN277

R30 10K

C29 .01UF

C28 .001UF

C30 .001UF

R31 47K

C31 .01UF

R32 4.7K

M

DB

POWER OFF

ON 10

METER OFF

S4a

AUDIO AMPLIFIER

MONITOR

S5

AUDIO IN

J2

R41 82K

R44 47K

R45 47K

R48 10K

C56 .01UF

R43 10K

V9 7360

R42 12K

C55 .01UF

C57 .01UF

R46 820

C58 200

R47 120K

AM

USB

LSB

C67 .01UF

Y2

Y3

C59 22

R50 10K

C60 .001UF

C61 .001UF

C62 .01UF

R51 240K

MON LEV

R103 250K

V10 6AQ5

C63 .01 UF

T4

+225V

R52 820

C64a 20UF

LS1

J3

HEADSET

LOCAL OSCILLATOR-MIXER

CR3a RY4306

CR3b RY4306

+75V

C34 .1UF

R33 487

R34 487

C32 .01UF

C33 .01UF

R35 1.6K

L4 500UH

C36 .01UF

V7 6CW4

V8 6CW4

R39 270

C37 100

R40 27K

R36 1.6K

R37 120K

C35 100

R38 110

C38 .001UF

S3 BANDSELECTOR

L5

L6

C39 4.5-25

C40 100

C41 4.5-25

C42 100

C43 4.5-25

C44 100

C45 4.5-25

C46 100

C47 4.5-25

C48 110

C49 4.5-25

C50 22

C51 155

C52 47

C53 4-10 CAL TRIM

C54 12-150 MAIN TUNING

POWER SUPPLY

WA

F1 1A

ON

S4b

J4 AC

T5

CR4 SM180

L7 7HY

C64b 40UF

C64c 40UF

+225V

R53 1.5K

V11 0A2

+150V

R54 8.2K

+75V

CR5 IN1792

C65 5UF

C66 .1UF

L8 63UH

V1, V2 V6, V7, V8

V3, V4 V10

V5

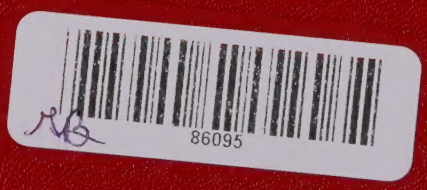
V9

DS1, DS2

NOTES

1. ALL CAPACITANCE IN PF UNLESS SPECIFIED, ALL RESISTANCE IN OHMS.
2. ALL PANEL CONTROL DESIGNATIONS ARE UNDERLINED.

RAILWAY COMMUNICATIONS INC. RAYTOWN, MO. KANSAS CITY, MO.	
SCHEMATIC 2173B SELECTIVE VOLTMETER PORTABLE	
DRAFTSMAN STEVENSON	DATE 5-8-64
PROJ ENG'R DFB	DWG. NO. 23-2173H
APPROVED BY	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